Non-White Race is an Independent Risk Factor for Hospitalization for Aortic Dissection

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Objective: To evaluate racial differences in the burden of aortic dissection.

Design: Retrospective analysis of a comprehensive state-wide inpatient database.

Setting: Acute care hospitals in the state of Maryland, 2009 – 2014.

Participants: All hospitalized adults with aortic dissection (AD), stratified by race.

Main Outcome Measures: Statewide and county-level population adjusted hospitalization rates, access to specialty aortic care, and mortality.

Results: Of 3,719,412 admissions to Maryland hospitals during the study period, 3,190 had AD (.09%; 1665 White, 1525 non-White). Non-White race was more common in patients with AD than without (48% vs. 41%, P<.0001). Adjusted for statewide demographics, admission for AD was 1.4 times more common among non-Whites (11 vs. 8 per 100,000, P<.0001). Non-White race was an independent risk factor for AD admission (OR 1.5, 95% CI 1.4 – 1.7). Among patients with AD, non-Whites were younger and more often female, but had similar or lower rates of cardiovascular comorbidities. Non-White race was not associated with decreased access to care or increased mortality.

Conclusion: Hospitalization for AD is more common among non-Whites, who develop AD at younger ages despite fewer comorbidities. While clinical correlates are limited from this dataset, this may reflect more severe pathophysiology related to clinical or socioeconomic factors among non-Whites. Further study is warranted to better define this disparity and identify high-risk subgroups who may benefit from aggressive primary prevention. *Ethn Dis.* 2016;26(3):363-368; doi:10.18865/ed.26.3.363

Introduction

Racial minorities are disproportionately affected by major cardiovascular disease.[1-5] Overall, control of blood pressure and blood glucose is worse among Blacks; adjusting for demographic and socioeconomic differences,[2,5] hypertension and diabetes are the leading contributors to higher mortality in Black Americans.[1] Additionally, Black patients undergoing major cardiovascular procedures are more likely to receive care at lower-volume and lower-quality hospitals, and have higher risk-adjusted postoperative mortality.[6-9]

Studies of the International Registry of Acute Aortic Dissection (IRAD) suggest racial differences in the presentation of acute aortic dissection (AD). For example, compared with White AD patients, Blacks are younger, have higher rates of hypertension, are more likely to have Type B AD, and experience delays to emergency operative repair in the setting of Type A AD.[10,11] However, further insights into racial disparities in AD are limited, partly because the broader epidemiology of AD is unclear.[12] Previous studies of AD have been limited to homogenous cohorts and are not applicable to demographically diverse populations.[13-16] The purpose of our study was to evaluate racial differences in AD by using a comprehensive, statewide inpatient database to analyze hospitalizations in the state of Maryland.

Methods

We conducted a retrospective analysis of AD in Maryland from 2009 – 2014 using the state-administered Health Services Cost Review Commission (HSCRC) database. The HSCRC inpatient dataset is updated quarterly to include information for all inpatient admissions to Maryland's 51 hospitals (2 specialty facilities, 3 psychiatric, and 46 acute care facilities).[17,18] De-identified data elements include patient-level

Keywords: Aortic Dissection; Cardiovascular Disease; Disparity

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demographics, International Classification of Diseases (ICD-9) procedure and diagnosis codes, All Patient Refined (APR) Diagnosis-Related Groups, APR adjusted severity of illness (SOI), and hospital disposition.[19] Race is coded as Caucasian, African American, Asian or Pacific Islander, American Indian/Eskimo, Other, Bi-Racial, or Unknown. The study was approved by University of Maryland, Baltimore institutional review board, with a waiver for subject consent given the use of de-identified data. The dataset was used under a Research Data Use Agreement approved by the HSCRC board.

Patients at least 18 years old were included for analysis. AD was defined by the presence of any ICD-9 code for aortic dissection (44100, 44101, 44102, or 44103). Because the dataset is de-identified without a mechanism to track readmissions, AD episodes are expressed as admissions/100,000 and mortality is expressed as deaths/100 admissions. Based on resources for emergent and complex cardiovascular care, academic medical centers with vascular and thoracic surgical fellowships were classified as tertiary hospitals. Concurrent statewide and county-level population data were obtained from the Maryland State Data Center.[20] County-level income inequality was assessed by the Gini coefficient, which ranges from 0 to 1 with higher values indicating greater inequality.[21]

Based on exploratory analyses demonstrating that non-White racial subgroups had similar risk for AD, patients were classified as White (Caucasian) or non-White for comparisons. The primary outcome was inpatient mortality; secondary outcomes were tertiary hospital admission and aortic intervention, which were used as markers of access to specialized care.

The purpose of our study was to evaluate racial differences in aortic dissection by using a comprehensive, statewide inpatient database to analyze hospitalizations in the state of Maryland.

Analyses between non-AD and AD patients, and between White and non-White AD patients were performed using chi-squared, Satterthwaite *t*, or Wilcoxon tests as appropriate. Evaluation of the association between demographic variables and county AD admission rates was by linear regression. Multivariable logistic regression analysis was performed using automatic step-wise selection and retention in the model for P<.01. Model fit was assessed by the Hosmer-Lemeshow goodness of fit test. The relationship between county demographic data and AD admission rates was tested by linear regression analysis, with factors associated with AD with P<.10 included in multivariable linear regression modeling using forward selection. Data were analyzed using SAS 9.3 software (SAS Institute).

Results

From 2009 – 2014, there were 3,716,222 admissions in the state of Maryland, including 3,190 (.09%) with AD. Compared with other hos-

Table 1. Comparison of hospitalized patients with and without AD, and between White and non-White AD patients[a]

	Non–AD, n= 3,716,222	All AD, n=3,190	P	White AD, n=1,665	Non-White AD, n=1,525	P
Age, years ± SD	57 ± 20	65 ± 16	< .0001	70 ± 15	61 ± 16	< .0001
Male	1,515,642 (41)	1,891 (51)	< .0001	1038 (62)	853 (56)	< .001
Non-White	1,529,532 (41)	1,525 (48)	< .0001			
Diabetes	927,599 (25)	612 (19)	< .0001	294 (18)	318 (21)	< .05
Hypertension	1,238,022 (33)	1,492 (47)	< .0001	797 (48)	695 (46)	.19
CAD	741,640 (20)	1,046 (33)	< .0001	656 (39)	390 (26)	< .0001
CHF	438,562 (12)	621 (19)	< .0001	342 (20)	279 (18)	.11
COPD	410,776 (11)	568 (18)	< .0001	371 (22)	197 (13)	< .0001
CKD	653,480 (18)	1,021 (32)	< .0001	483 (29)	538 (35)	< .0001
Tobacco use	726,240 (20)	745 (23)	< .0001	370 (22)	375 (25)	.11

a. Data are n (%) unless noted otherwise.
CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; CKD, chronic kidney disease.

pitalized patients, those with AD were older, more often male, and – except for diabetes – had higher rates of comorbidities (Table 1). Minority race was more common in patients with AD than without (48% vs 41%, P<.0001), and adjusting for demographics and comorbidities, patients with AD were more likely to be non-White (OR 1.5, 95% CI 1.4 – 1.6).

Among the AD group, there were 1,665 (52%) White and 1,525 (48%) non-White patients (Table 1). The non-White group was 84% African American, 2% Asian or Pacific Islander, 9% other unspecified race, and 5% were of unknown race. Compared with White AD patients, non-Whites were younger (61 ± 16 vs 70 ± 15 years, P<.0001) and more often female (44% vs 38%, P<.001). Non-White patients had higher rates of diabetes and renal insufficiency, but had similar or lower rates of other cardiovascular comorbidities.

The overall inpatient mortality rate for AD was 7.5/100 admissions, and was similar between subgroups (Whites 8% vs. non-Whites 7%, P=.22; Table 2). Non-White patients were admitted to tertiary hospitals more frequently than Whites (42% vs 37%, P<.01). However, after controlling for age, sex, APR-SOI, and comorbidities, race was not independently associ-

Table 2. Comparison of primary and secondary outcomes between White and non-White AD patients

	White, n=1665	Non-White, n=1525	*P*
Mortality, n (%)	135 (8)	106 (7)	.22
Tertiary hospital admission, n (%)	609 (37)	633 (42)	<.01
Aortic intervention, n (%)	368 (22)	321 (21)	.47
Inpatient length of stay, days (IQR)	4 (2 – 8)	5 (2 – 9)	<.01

IQR, interquartile range.

Table 3. Summary of county population and AD hospitalization rates

County	Average population			AD per year			AD admissions / 100,000		
	Total, n	White, n (%)	Non-white, n (%)	Total	White	Non-white	Total	White	Non-white
Allegany	73,743	66,154 (90)	7,589 (10)	6	6	0	9	2	8
Anne Arundel	544,923	421,964 (77)	122,959 (23)	40	26	13	6	11	7
Baltimore City[a]	624,447	198,065 (32)	426,381 (68)	109	27	82	14	19	17
Baltimore County	812,524	533,814 (66)	278,710 (34)	110	63	47	12	17	14
Calvert	89,673	73,515 (82)	16,158 (18)	3	1	2	2	9	3
Caroline	32,874	26,997 (82)	5,876 (18)	3	3	0	9	6	9
Carroll	167,850	156,548 (93)	11,302 (7)	15	14	2	9	16	9
Cecil	101,581	91,631 (90)	9,950 (10)	2	2	0	2	3	2
Charles	149,399	76,219 (51)	73,180 (49)	6	4	1	5	2	4
Dorchester	32,529	22,411 (69)	10,117 (31)	3	1	1	6	12	8
Frederick	237,210	199,289 (84)	37,921 (16)	21	17	4	9	10	9
Garrett	29,862	29,242 (98)	619 (2)	3	3	0	9	0	9
Harford	246,980	202,287 (82)	44,693 (18)	16	11	5	5	10	6
Howard	295,970	188,079 (64)	107,891 (36)	13	10	3	5	3	4
Kent	20,095	16,455 (82)	3,639 (18)	2	2	0	12	0	10
Montgomery	997,758	637,551 (64)	360,207 (36)	43	23	21	4	6	4
Prince George's	874,673	233,220 (27%)	641,453 (73)	49	9	40	4	6	6
Queen Anne's	48,331	43,401 (90)	4,931 (10)	4	4	0	9	7	9
Somerset	26,185	14,312 (55)	11,873 (45)	2	1	1	5	10	7
St. Mary's	107,486	85,637 (80)	21,848 (20)	4	3	1	3	5	3
Talbot	37,604	31,479 (84)	6,125 (16)	3	3	1	9	8	9
Washington	148,399	127,062 (86)	21,337 (14)	10	6	4	5	17	7
Wicomico	99,323	69,774 (70)	29,549 (30)	11	8	3	11	11	11
Worcester	51,144	42,477 (83)	8,667 (17)	5	4	2	9	17	10
Total	5,850,560	3,587,584 (61)	2,262,976 (39)	481	249	232	8	7	10

a. Baltimore City is an independent city with county status.

Table 4. Association between county demographic data and AD hospitalization rates.

County variable	Coefficient (95% CI)	R^2	P	Cumulative R^2	Cumulative P
GINI income inquality[a]	1.05 (1.02 – 1.07)	.39	.001	.39	.001
Income[b]	.36 (.19 – .70)	.32	.04	.42	.003
Unemployment rate, %	2.61 (.94 – 7.28)	.15	.06	.45	.007
Uninsured, %	1.53 (.88 – 2.66)	.10	.12		
Age > 65, %	1.26 (.90 – 1.77)	.09	.16		
Non-white, %	1.03 (.95 – 1.12)	.03	.46		

a. Scaled per 1/10th % of the GINI coefficient.
b. Median household income, scaled per $10,000.

ated with tertiary hospital admission (OR .9, IQR 0.8 – 1.1). The patient groups had similar rates of aortic intervention (22% vs 21%, P=.47).

The average state population during this period was 5,858,000, for an annual hospitalization rate of 9 AD admissions/100,000. Adjusted for state demographics (61% White, 39% non-White), minorities had a significantly higher burden of AD (11 vs 8 admissions/ 100,000, P<.0001). By county of residence, the median per county admission rate was 8/100,000 (IQR 5 – 9), and ranged from 2 to 17 per 100,000 (Figure 1; Table 3). On linear regression analysis, higher per-county AD admission rates were associated with decreasing median household income and increasing income inequality (Table 4). There was also a strong trend toward increasing AD admission rates in counties with higher unemployment rates.

Discussion

Our study provides new insight into patterns and disparities associated with AD. By using a comprehensive statewide inpatient database and demographic data from a diverse and representative population, our study adds to the existing literature regarding the burden of AD in the United States. Importantly, AD disproportionately affects non-Whites who are more likely to be hospitalized for AD and develop AD at younger ages. Suggesting a socioeconomic component to AD risk, county-level variation in AD admission rates vary substantially in association with income and income inequality. However, despite these disparities, Whites and non-Whites have similar outcomes.

To our knowledge, this is the first demographically diverse, population–based analysis of the burden of AD. Previous epidemiologic studies of AD have reported AD incidence of 3 – 6/100,000, but have been limited to small and/or homogenous populations.[13-16,22] For example, the Oxford Vascular Study reported AD incidence of 6/100,000, but studied a population that was 94% White that may not be representative outside of Western Europe.[22] The AD hospitalization rate in this study of 9/100,000 was similar to the 10/100,000 in a recent study of the United States National Inpatient Sample (NIS) by Mody et al,[23] but by accounting for state and county population data, our analysis gives new insight into the relationships between demographics and disparities as they relate to AD.

Our analysis found strong associations between non-White race and admission for AD among Maryland residents and hospitalized patients. This regional phenomenon likely reflects a national disparity, as the different racial admission rates are similar to an NIS study that estimated nationwide AD admission rates for Whites and Blacks of 9 and 14/100,000, respectively.[23] Non-White patients in our study presented differently: they were more often female and were younger, despite similar or lower rates of most comorbidities. Further, the associations

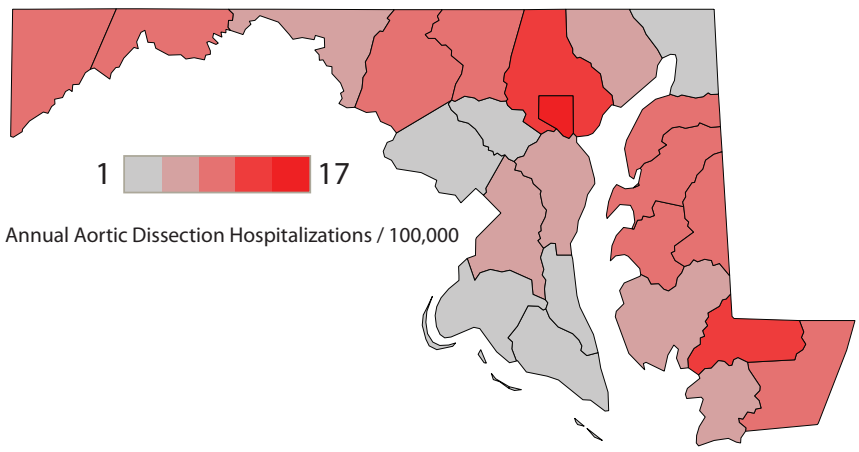

Figure 1. Map of per county aortic dissection admission rates

between lower income, greater income inequality, and AD admissions suggest an important socioeconomic component for AD risk and development.

The exact relationship between individual medical factors, socioeconomic influences, and AD is unclear from our study. This is entirely a reflection of the limitations of the HSCRC database. An analysis of the IRAD by Bossone et al found that Black patients are more likely to present with Type B AD, which may represent a different underlying susceptibility within specific aortic diseases.[11] The younger ages of minority AD patients demonstrated in both the present study and in IRAD could represent greater underlying susceptibility to AD, worse control of comorbidities, or a combination of both.[11] For example, minorities have higher rates and worse control of hypertension.[2,5] Potentially contributing to the younger average age of non-White AD patients in this study, differences in disease control are greater for Black patients younger than aged 65 years, who historically have less access to federal health insurance programs.[2]

More broadly, socioeconomic factors are associated with differences in individual, community, and national health.[21,24-26] For example, higher educational attainment and income are associated with reduced smoking prevalence and lower blood pressure and cholesterol levels.[24] Additionally, after adjusting for income, greater income inequality is associated with adverse cardiovascular comorbidities.[25,26] The direct relationship between such factors and individual health is unclear, but is likely multifactorial and related to economic disadvantages, psychosocial stressors, and poor availability and access to health care.[2,24-26] Consistent with socioeconomic inequality contributing to AD, median household incomes for White Marylanders are 39% and 20% higher than for Black and Hispanic households, respectively.[20]

Previous studies have suggested racial differences in AD management. For example, in an analysis of the IRAD, Harris et al found that non-White race was associated with significant delays to surgical repair of Type A AD.[10] While our study was unable to evaluate specific aspects of patient management, there was no independent relationship between race and tertiary hospital admission or rates of aortic intervention. In contrast to higher mortality for minorities undergoing elective major cardiovascular procedures, such as coronary revascularization, abdominal aortic aneurysm repair, or carotid endarterectomy,[6,8,9] inpatient mortality rates were similar between racial groups. This lack of disparity in outcomes may be due to the typically emergent nature of AD or triage to higher quality hospitals for surgical care.[6,9]

While offering novel insights into patterns and outcomes of AD, our study has several important limitations. Because a de-identified database was used, we were unable to track unique patients to determine true incidence and mortality rates. Not only would readmissions overestimate incident events, but potential disparities in readmissions could have skewed the relative burdens of AD in this analysis. Further, as the HSCRC inpatient dataset does not include patient-level socioeconomic variables, we relied on state and county-level data that may have reduced our ability to define relationships between socioeconomic conditions and individual medical factors and outcomes. For example, we could not directly implicate income and income inequality with differences in AD admission rates. Finally, due to the non-specific diagnostic coding of AD within the database, we were unable to differentiate between different AD classifications, which have been associated with racial differences in other studies.[11]

Despite these limitations, by using actual patient and state data – not estimates – we were able to accurately assess the burden and disparity of AD in a large, and demographically diverse population. As the first extensive, population based analysis of AD in the United States, it helps to establishes the public health and medical system burden of AD, and points to disparities in critical aortic disease. Future research should define the epidemiology of the disease, and better elaborate the relationships between medical and socioeconomic risk factors and development of AD.

Conclusion

Racial minorities are disproportionately affected by AD in Maryland. Non-Whites are hospitalized for AD more frequently than Whites, and develop dissection at earlier ages despite similar comorbidity profiles. There is substantial variation in AD rates within the state that is related to socioeconomic factors that may account for this racial disparity. Further study is required to define the epidemiology of AD and elucidate the medical and socioeconomic factors that contribute to racial differences in the burden of AD.

Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Harris, Klyushnenkova, Garrido, Bhardwaj, Rabin, Toursavadkohi, Diaz, Crawford; Acquisition of data: Harris, Klyushnenkova, Kalsi, Bhardwaj, Diaz; Data analysis and interpretation: Harris, Klyushnenkova, Bhardwaj, Rabin, Toursavadkohi, Crawford; Manuscript draft: Harris, Kalsi, Garrido, Rabin, Diaz, Crawford; Statistical expertise: Harris, Klyushnenkova, Bhardwaj; Administrative: Klyushnenkova, Kalsi, Garrido, Bhardwaj, Rabin, Toursavadkohi, Crawford; Supervision: Harris, Diaz, Crawford

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